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The impact of 14th Malaysian General Election on Bursa Malaysia by using a complex network approach

*[1]Hafizah Bahaludin, [2]Fatin Nur Amirah Mahamood, [3]Muhammad Hasanuddin Amran

***ABSTRACT**--A complex system such as a financial market can be visualized in the form of a network. For instance, a network is used to exhibits the interconnection between stocks that are traded in the market. In addition, it shows many important embedded information in a network such as structural changes that are affected from any events. Even though, the applications of a complex network has been used to investigate the behaviour of Bursa Malaysia, far too little attention has been paid to the effect of political event towards Malaysian financial market. Thus, this study concentrates the effect of 14th Malaysian General Election towards Bursa Malaysia. The first objective is to construct a financial network of Bursa Malaysia and the second objective is to examine the importance of the stocks on the financial network. The data used are the shariah-compliant stocks listed on Shariah Advisory Council (SAC). The duration of the study is divided into two periods which are the six months before and after the general election. The minimal spanning tree is used to construct a network and centrality measures are used to examine the role of a stock in a network. The empirical findings revealed and shed light on the impact of the 14th Malaysian General Election on shariah-compliant securities.*

***Keywords**--Network; Bursa Malaysia; Minimal Spanning Tree, Centrality Measures*

I. INTRODUCTION

Financial network is useful to represent the interconnection of stocks that are traded in the stock market. Essentially, the cross-correlations of stocks are used as inputs to construct a financial network as proposed in seminal work of Mantegna (1999). This approach is widely used with different purposes such as to investigate the changes of topological properties of financial network (Tabak, Serra, & Cajueiro, 2010; Yao & Memon, 2019), to identify the stocks to improve the portfolio strategy (Li, Jiang, Tian, Li, & Zheng, 2018; Peralta & Zareei, 2016; Pozzi, Di Matteo, & Aste, 2013) and to examine the impact of financial crisis towards the stock market (Aswani, 2017; Coletti & Murgia, 2016; Lee & Nobi, 2018; Majapa & Gossel, 2016; Memon & Yao, 2019; Tabak et al., 2010). However, very little research has been carried out to investigate the impact of political situations such as a general election by using a financial network. For instance, Memon, Yao and Tahir (2020) examined the impact of the general election towards the Pakistan's stock market and the results indicated that the general election affected the structure of Pakistan's stock market.

[1]* *Department of Computational and Theoretical Sciences, Kulliyyah of Science, International Islamic University Malaysia, Kuantan, Pahang, 25200, Malaysia, hafizahbahaludin@iium.edu.my*

[2] *Department of Computational and Theoretical Sciences, Kulliyyah of Science, International Islamic University Malaysia, Kuantan, Pahang, 25200, Malaysia.*

[3] *Department of Computational and Theoretical Sciences, Kulliyyah of Science, International Islamic University Malaysia, Kuantan, Pahang, 25200, Malaysia.*

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Previous literature showed that a financial network has been constructed for Bursa Malaysia securities. In Malaysian market, normally a financial network is signified based on the top hundred most capitalized stocks, but, with different time periods (Bahaludin, Abdullah, Siew, & Hoe, 2019; Djauhari & Gan, 2014a; Gan & Djauhari, 2012; Lim, Salleh, & Asrah, 2018; Mahamood, Bahaludin, & Abdullah, 2019; Sharif & Djauhari, 2012). The effect of recession periods for conventional stocks listed on Bursa Malaysia can be found in seminal work of Bahaludin, Abdullah, Siew and Hoe (2019). In addition, Mahamood, Bahaludin and Abdullah (2019) took a different perspective by employing shariah-compliant stocks to examine the effect of global financial crisis in the year 2008. The results of aforementioned studies that are related to Malaysian's stock market provide evidences that the network topology has changed with respect to the different periods, different stocks and different occasions.

Therefore, this paper examines the impact of 14th Malaysian General Election towards shariah-compliant stocks that are listed on Bursa Malaysia. In addition, key stock is identified for the duration of six months before and after the general election. In summary, this study has two contributions. Firstly, this study provides a deeper insight into the changes of the correlations between the shariah-compliant stocks that were affected by political event in Malaysia. Secondly, this study can be used to help market participants in identifying central stocks in Bursa Malaysia.

This paper is structured as follows. Section 2 presents the data set and elaborates the methods use in order to achieve the objectives. Section 3 presents the findings of the research and Section 4 is the conclusion.

II. DATA AND METHODOLOGY

2.1 Data

This paper uses the stock prices of 122 shariah-compliant companies that consistently listed on Shariah Advisory Council from the year of 2008 until 2018. The duration of the data is divided in two periods, that is, six months before and after 14th Malaysian General Election that was held on the 9th May 2018. Specifically, six months before the general election covers the date from 9th November 2017 until 8th May 2018. On the other hand, six months after the general election starts from 10th May 2018 until 9th November 2018. The data is extracted from the financial database, Eikon Datastream. In total, the duration of this study covers 261 trading days.

2.2 Methodology

This subsection presents the procedures of minimum spanning tree (MST), centrality measures and principal component analysis (PCA).

2.2.1 Minimum spanning tree (MST) method procedures

To illustrate the connectivity of every stocks, MST method is employed by firstly, calculating the logarithmic return of stock's prices. The return, $r_i(t)$, is calculated by substituting the stock's prices, $P_i(t)$, into the $r_i(t) = \ln \frac{P_i(t+1)}{P_i(t)}$ equation, $t(t = 1, 2, 3, ..., z)$, where z is the number of trading days and i is a stock. Secondly, the return is used to determine the similarity between stock i and stock j in which denoted by α_{ij}. In this paper, in order to determine the similarities among stocks, Pearson's Correlation Coefficient (PCC) formula is applied as

stated in equation (1). Subsequently, the correlations are demonstrated by $N \times N$ correlation matrix, *C*, where *N* is the total number of stocks and $E(r_i(t)) = \frac{1}{N}\left(\sum_{t=1}^{N} r_i(t)\right)$ as well as $-1 \le \alpha_{ij} \le 1$.

$$\alpha_{ij} = \frac{E(r_i(t)r_j(t)) - E(r_i(t))E(r_j(t))}{\sqrt{Var(r_i(t))Var(r_j(t))}}, \quad (1)$$

Thirdly, matrix, *C*, is changed to a distance matrix, *D*, because the correlation coefficient, α_{ij}, is failed to fulfill the three distance matrix axioms which are stated in Mantegna (1999). 9). The element of distance matrix, *D*, is identified by $\gamma_{ij} = \sqrt{2(1-\alpha_{ij})}$ formula with γ_{ij} can varies from 0 to 2. To finish, Kruskal's algorithm is applied to construct MST (Kruskal, 1956). Kruskal's algorithm is applied because it is mathematically appealing (Malkevitch, 2012), a simple algorithm without complex computation (Nesetril, 1997) and no optimality problem occurs (Djauhari & Gan, 2013, 2014b).

2.2.2 Centrality measures method

The centrality measures are employed to extract the information that is embedded in a financial network whereby the measures identify the key player based on different characteristics. According to Freeman (1977), centrality measures are employed to clarify the prominence of every node in a network. Thus, this paper clarifies the prominence of every stock based on four distinctive characteristics by using degree, betweenness, closeness and eigenvector centrality measures.

Degree centrality determines the prominent stock based on the total adjacent links of particular stocks (Freeman, 1978). A node with high connected links, will be the node that is the most prominent. By using equation (2), the degree centrality of stock *i*, is identified.

$$D(i) = \frac{1}{N-1}\left(\sum_{j}^{N} A_{ij}\right), \quad (2)$$

with A_{ij} is the element of adjacency matrix. A stock is considered as the most important stock on a financial network if the stock obtains the highest value of degree centrality, $D(i)$. In other words, a stock with the highest value of degree centrality has the highest connectivity with other stocks.

Betweenness centrality examines the tendency of a node to act as a mediator in a network (Freeman, 1978). Betweenness centrality can be computed by using equation (3),

$$B(i) = \sum_{j<q} \frac{u_{jq}(i)}{u_{jq}}, \quad (3)$$

where $u_{jq}(i)$ is the total shortest paths from node *j* to node *q* that go through node *i*. Meanwhile, u_{jq} is the total minimum distances from *j* to *q*.

Closeness centrality measures the proximity to other vertices on a network. The calculation involves the minimum distance from each vertex to all other vertices (Freeman,1978). A node that exhibits the highest value has the power to spread the information fastest since the node can reach other nodes through the shortest path. The closeness centrality of stock *i* is signified as in equation (4),

$$C(i) = \left[\sum_{j=1}^{N} h(i, j) \right]^{-1}, \quad (4)$$

with $h(i, j)$ is the shortest path from node *i* to node *j*.

The fourth measure is eigenvector centrality in which it considers a prominence node, that is a node that linked to other vital nodes (Bonacich, 1987). This measure implies that a node that has the smallest number of neighbouring nodes can be considered as a crucial node because the node is linked to other crucial nodes. Eigenvector centrality is expressed as

$$Eig(i) = \lambda^{-1} \sum_{j=1}^{N} K_{ij} y_j \text{ for } i = 1, 2, ...N. \quad (5)$$

Besides, the expression can be written as $K_{ij} Eig(i) = \lambda Eig(i)$, where K_{ij} is an adjacency matrix and $Eig(i)$ is an eigenvector of the leading eigenvalue, λ.

2.2.3 Principal component analysis (PCA) method procedures

All the aforementioned centrality measures are summarized by using a principal component analysis (PCA) method. PCA reduces a complex large matrix with a minimum number of information loss (Jolliffe, 2002). This study applies PCA to compute the overall centrality measure, $O(i)$, in determining the importance of every stock entirely. The procedures to calculate the overall centrality measure starts with computing a $N \times M$ matrix where *N* is the total stocks and *M* is the number of centrality measures used. Next, a covariance matrix, *Q*, is set up. Then, eigenvector, $w = (w_1, w_2, w_3, ..., w_M)$ of the maximum eigenvalue, $\theta_{\max}$, is determined using the formula $Qw = \theta_{\max} w$. In general, the maximum eigenvalue is called a first principal component in which it contains the largest percentage of variance (Jolliffe, 2002). The procedures end by taking the linear combination of the original centrality value, defined as, $O(i) = w_1 D(i) + w_2 B(i) + w_3 C(i) + w_4 Eig(i)$, where $D(i)$, $B(i)$, $C(i)$ and $Eig(i)$ are the respective degree, betweenness, closeness and eigenvector.

III. RESULTS AND FINDINGS

3.1 Minimum Spanning Tree (MST)

Figure 1 shows a minimum spanning tree (MST) of the period of six months before general election. The financial network presents a star-like structure of the MST. Generally, the network has several clusters in which dominated by five companies namely MEM, ALG, WCTH, KT and FBG (herewith, please refer Appendix for the abbreviations). As can be seen in Figure 1, MEM seems be the central node in the network with 9 links, ALG was connected to another 7 links and WCTH had 5 links. KT and FBG shared the same number of links that is 5 links each. Some of the companies within the same sector classification tend to cluster together. For example, ALG, AI, STH, UMS, TML and CF are the companies from industrial product and services located together on the network. Similar with another cluster that consists of KT, FIH, FH, KHDH, PRGU and BRH in which they are in the consumer and product services classification. Another important finding is that the financial network exhibits connections between one sector with other sectors such as the construction sector was connected to the industry, finance and telecommunication sector as displayed in Figure 1.

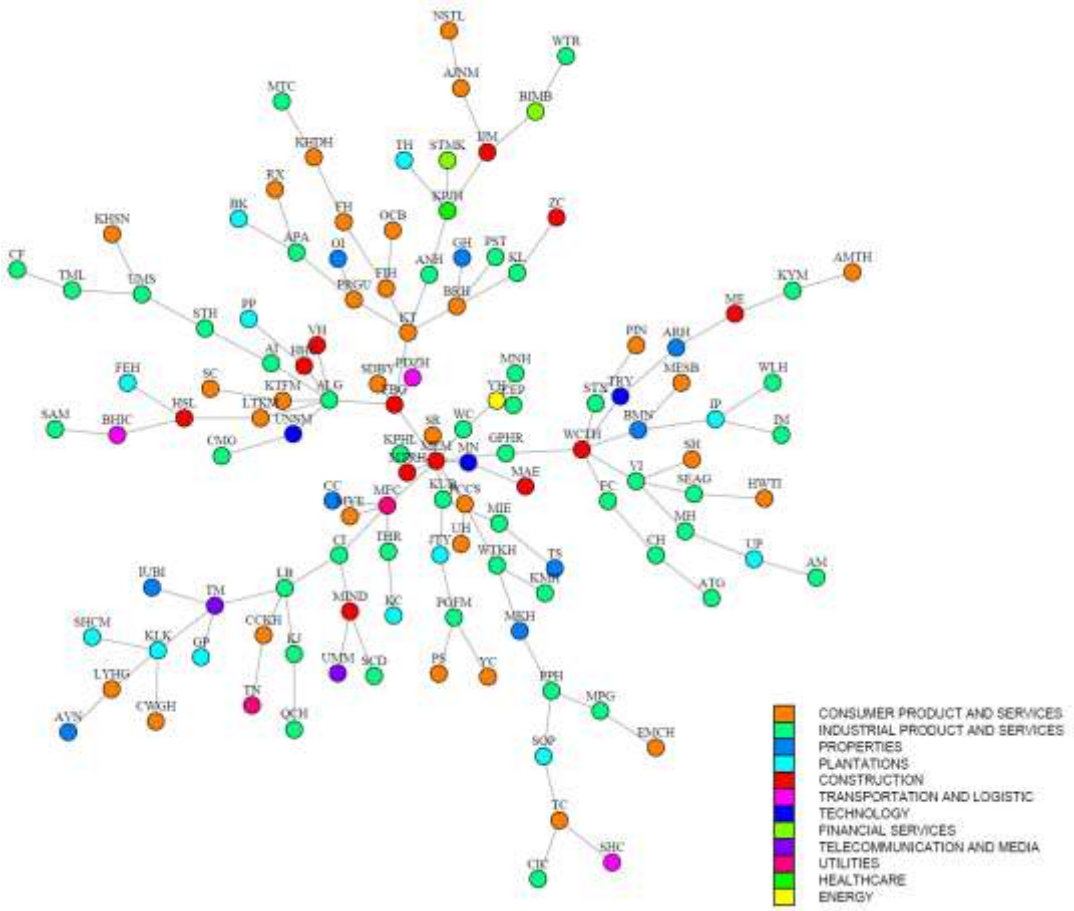

Figure 1: Minimum spanning tree of Malaysian shariah-compliant stocks before the 14th Malaysian General Election.

After the general election took place, the star-like structure has changed into a tree-structure of MST as depicted in Figure 2. In addition, the most connected stock before the six months after the general election was no longer in the same position after the general election. The results indicate that the impact of the general election on the shariah-compliant stocks is tremendous. In this period, Figure 2 shows that KUB, MKH, HHC, TN and SDBY are the major stocks. The finding exposes that KUB was the largest cluster even though the company does not has a big market capitalizations as compared to TN and SDBY. In post period of the general election, this study identifies that the Malaysian market had a strong dependence on the industry, property, construction, utilities and consumer sectors.

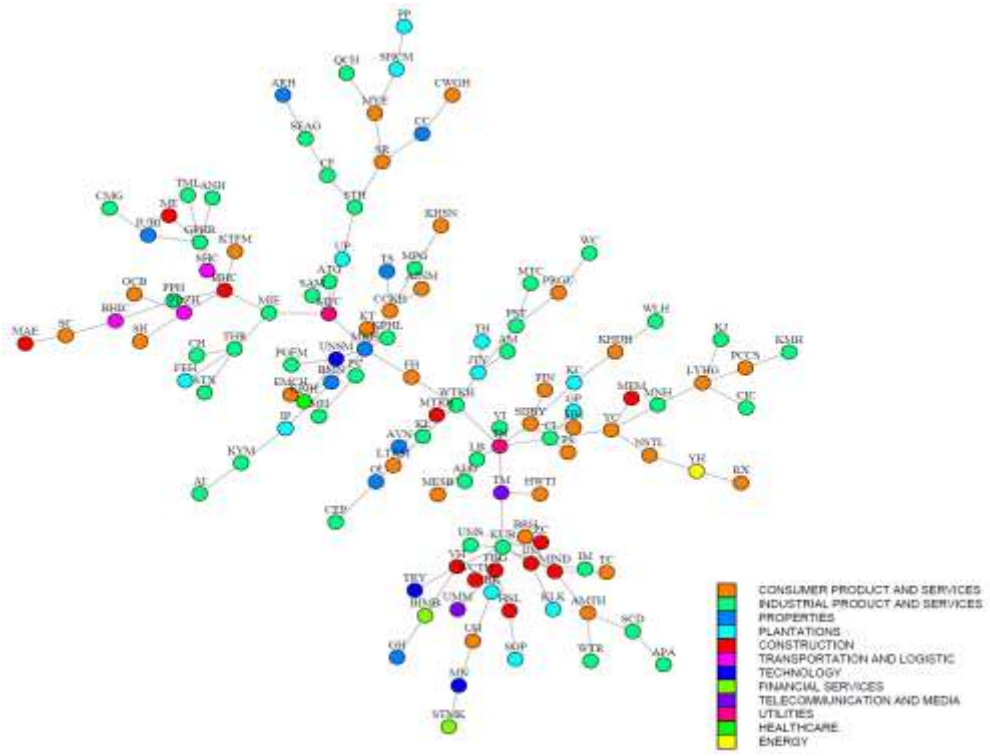

Figure 2: Minimum spanning tree of Malaysian shariah-compliant stocks after the 14th Malaysian General Election

3.2 Centrality measures

This subsection presents the results of centrality measures to examine the behaviour of each stock based on the four criteria such as degree, betweenness, closeness and eigenvector. The principal component analysis is applied to conclude the overall performance of each stock in the network for all the periods as the seminal work of other researchers (Gan & Djauhari, 2012; Pasini, 2017).

3.2.1 Degree centrality

Before the 14th General Election (GE), MEM exhibited the highest value followed by ALG, WCT, KT and FBG with values as presented in Table 1. The findings depicted that these 5 stocks have many other stocks connected to them such as MEM connected to other 9 stocks. KT and FBG have similar degree centrality values because they have similar number of stocks connected to them which is 5 stocks. Additionally, before general election, construction sector played the most influential role since 3 out of 5 stocks are from the construction sector. However, as the general election took place, the aforementioned stocks lost their connectivities and were replaced by KUB, MKH, HHC, TN and SDBY, where KUB was the uppermost stocks as shown in Table 2. The results depict that the political event has strong impact on Malaysian shariah-compliant stocks' network. In terms of sectorial basis, this study finds that the consumer and construction industry remains as the top five influential sectors followed by property and utilities sectors. It seems that the property and utilities sectors experienced an increase in connectivity after the general election as presented in Figure 2. This escalation in the number of connections emphasizes the growth of economic activities of property and utilities sectors during the elections.

Table 1: The five highest degree centrality measures before the 14th Malaysian General Elections

Name	Label	Sector	Degree centrality value
Muhibbah Engineering	MEM	Construction	0.074
Alcom Group	ALG	Industry	0.058
WCT Holdings	WCTH	Construction	0.050
Konsortium Transnasional	KT	Consumer	0.041
Fajarbaru Builder Group	FBG	Construction	0.041

Table 2: The five highest degree centrality measures after the 14th Malaysian General Election

Name	Label	Sector	Degree centrality value
KUB Malaysia Berhad	KUB	Industry	0.074
MK Land Holdings	MKH	Property	0.066
Ho Hup Construction	HHC	Construction	0.050
Tenaga Nasional	TN	Utilities	0.050
Sime Darby	SDBY	Consumer	0.041

3.2.2 Betweenness centrality

Figure 2 shows that MEM was the centre of the network before the general election period. The result is further proven by the betweenness centrality measure in which MEM has the highest value which is 0.766 as depicted in Table 3. This study exposes that MEM was the mediator that transferred the information from one node to other nodes in the network with respect to political regime shifts and fluctuation of the stock's price. It can be said that if MEM experiences a failure, then, other connected stocks will also have the same experience. Therefore, MEM played an important role in terms of betweenness centrality before the general election. The rank followed by FBG, KT, WCTH and GPHR as shown in Table 3. Additionally, the construction sector was the most influential sector before the general election.

In the post period of general election, TN replaced MEM as the utmost important stock in the Malaysian shariah-compliant stocks' network. Then, tailed by WTKH, MKH, FH and MFC as shown in Table 4. As depicted in Figure 2, these 5 stocks played important roles in the network in which, their failures can result in the failures of other clusters that are attached to them. According to sectorial basis, the utilities sector appeared twice in the top 5 list which makes the utilities sector the most influential sector after the general election instead of the construction sector as before the general election. There were changes in the performance of stocks as the general election impacted the network.

Table 3: The five highest betweenness centrality measures before the 14th Malaysian General Election

Name	Label	Sector	Betweenness centrality value
Muhibbah Engineering	MEM	Construction	0.766

Fajarbaru Builder Group	FBG	Construction	0.553
Konsortium Transnasional	KT	Consumer	0.350
Wct Holdings	WCTH	Construction	0.326
Golden Pharos	GPHR	Industry	0.310

Table 4: The five highest betweenness centrality measures after the 14th Malaysian General Election

Name	Label	Sector	Betweenness centrality value
Tenaga Nasional	TN	Utilities	0.611
WTK Holdings	WTKH	Industry	0.602
MK Land Holdings	MKH	Property	0.596
Fiamma Holdings	FH	Consumer	0.498
Mega First Corporation	MFC	Utilities	0.459

3.2.3 Closeness centrality

According to closeness centrality measure, the top 5 stocks for the periods before and after the general election were different except MFC. In the pre-GE, MEM remained as the most important stock. This means that MEM had many stocks connected to MEM. The 3 closest stocks to MEM are GPHR, KUB and FBG as displayed in Figure 1. Hence, MEM spread the information faster than other stocks especially to these 3 closest stocks. The other important stocks before the GE are FBG, GPHR, MFC and PCCS as depicted in Table 5. The constructions sector was the most influential sector. In addition, for the first time, utilities sector appears as the top 5 sectors before the general election. The results explained that the utilities sector happened to have a strong relationship with other stocks although it does not have many direct links and has a weak mediation effect.

Different with before the general election, WTKH had a large closeness centrality value of 0.190 after the 14th general election, followed by FH (0.186), TN (0.184), MKH (0.181) and MFC (0.168). This result is interpreted as the key stocks in the network based on the closeness centrality measure. In sectorial basis, this study observes that the construction sector has disappeared, while, the property sector is included after the GE as presented in the Table 6. The industry, consumer and utilities sectors remained in the top 5 list with the utilities sector as the most influential sector.

Table 5: The five highest closeness centrality measures before the 14th Malaysian General Election

Name	Label	Sector	Closeness centrality value
Muhibbah Engineering	MEM	Construction	0.230
Fajarbaru Builder Group	FBG	Construction	0.218
Golden Pharos	GPHR	Industry	0.202
Mega First Corporation	MFC	Utilities	0.199
PCCS Group	PCCS	Consumer	0.192

Table 6: The five highest closeness centrality measures after the 14th Malaysian General Election

Name	Label	Sector	Closeness centrality value
WTK Holdings	WTKH	Industry	0.190
Fiamma Holdings	FH	Consumer	0.186
Tenaga Nasional	TN	Utilities	0.184
MK Land Holdings	MKH	Property	0.181
Mega First Corporation	MFC	Utilities	0.168

4.2.4 Eigenvector centrality

Before the general election period, MEM was the most important stock in the network followed by FBG, ALG, MFC and KUB with values depicted in Table 7. Figure 1 shows that MEM is connected to other important stocks such as FBG in which FBG was consistently the top stock in degree, betweenness and closeness centrality measures. Besides, MEM also is connected to PCCS, GPHR and MFC as they are the top 5 stocks in closeness centrality measure. In eigenvector centrality, both construction and industry sectors are the most influential sector as each of the sector appears twice in Table 7.

In the post period of general election, MKH was the most important stock according to eigenvector centrality, followed by KUB, TN, WTKH and TM with their respective values as presented in Table 8. Although the number of adjacent stocks is no high compared to other stocks, but TM is connected to stocks that played important roles in degree, betweenness and closeness centrality measures, which are stocks like TN and KUB. Hence, this makes TM is listed as the top 5 stocks in the eigenvector centrality measure after the general election. In general, eigenvector centrality measure reveals that the industry sector was the most influential sector.

Table 7: The five highest eigenvector centrality measures before the 14th Malaysian General Election

Name	Label	Sector	Eigenvector centrality value
Muhibbah Engineering	MEM	Construction	0.532
Fajarbaru Builder Group	FBG	Construction	0.348
Alcom Group	ALG	Industry	0.274
Mega First Corporation	MFC	Utilities	0.252
KUB Malaysia Berhad	KUB	Industry	0.204

Table 8: The five highest eigenvector centrality measures after the 14th Malaysian General Election

Name	Label	Sector	Eigenvector centrality value
MK Land Holdings	MKH	Property	0.374
KUB Malaysia Berhad	Industry	Industry	0.359
Tenaga Nasional	TN	Utilities	0.282
WTK Holdings	WTKH	Industry	0.230
Telekom Malaysia	TM	Telecommunication	0.220

3.2.5 Overall centrality

To summarize the centrality measures, overall centrality is computed using principal component analysis (PCA). With the 90% of the cumulative proportion of variances, MEM has the highest value of overall centrality measure before the 14th Malaysian General Election as shown in Table 9. This result can be seen in all the centrality measures used; MEM is always at the utmost rank. This makes MEM played as the most important stock in the network as a whole before the general election. FBG, KT, MFC and ALG are the other important stocks. In terms of sector, construction sector was the most influential sector followed by consumer, utilities and industry sectors.

The total variance for the post general election period is 91.14%. The highest value of overall centrality belongs to MKH with a value of 0.631 as depicted in Table 10. Thus, it can be summarized that the most important stock as a whole was shifted to MKH after the general election. Then, tailed by TN, WTKH, FH and MFC. For sectorial basis, utilities sector was the most influential sector in the post period of general election instead of the construction sector in the pre-general election period. The industry and consumer sectors remained as top 5 in the list ofoverall centrality measures with the addition of property sector.

Above all, the overall centrality measure also revealed that, the only stock that remains as the top 5 important stocks is MFC. MFC appears in both before and after the general election, which seems that MFC is the least impacted by the general election.

Table 9: The five highest overall centrality measures before the 14th Malaysian General Election

Name	Label	Sector	Value
Muhibbah Engineering	MEM	Construction	0.869
Fajarbaru Builder Group	FBG	Construction	0.590
Konsortium Transnasional	KT	Consumer	0.334
Mega First Corporation	MFC	Utilities	0.327
Alcom Group	ALG	Industry	0.317

Table 10: The five highest overall centrality measures after the 14th Malaysian General Election

Name	Label	Sector	Value
MK Land Holdings	MKH	Property	0.631
Tenaga Nasional	TN	Utilities	0.603
WTKHoldings	WTKH	Industry	0.572
Fiamma Holdings	FH	Consumer	0.459
Mega First Corporation	MFC	Utilities	0.437

IV. CONCLUSIONS

Malaysian shariah-compliant stocks' network is constructed using minimum spanning tree (MST) method to visualize the correlations structure among stocks before and after the 14th Malaysian General Election. This study observes that the topological structure of the network changes when general election took place. The performance of every stock in the network is analyzed based on four different criteria namely degree, betweenness, closeness

and eigenvector centrality measures. To summarize the overall performance of each stock, principal component analysis (PCA) is employed. The results show that before the general election, Muhibbah Engineering (MEM) was the most important stock as a whole. After the general election, Muhibbah Engineering (MEM) was replaced by MK Land Holdings (MKH) as the most important stock. Overall, the results show that a political event affects the network structure as well as the stock's performance. Hence, market participants especially investors should take into account political events when making decision pertaining to portfolio strategy.

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